[Translation of Laid-open Patent Application No. S[howa] 63-141432; pp. 173 - 176]
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⑲ Japan Patent Office (JP)
(12)Laid Open Patent Official Gazette (A)

⑪ Laid-Open Patent Application
Sho[-wa]63-141432

(51) Int. Cl.	Identification Symbols	Patent Office Internal Control Numbers	(43) Laid-open [Date]: June 13, 1988
H 04 L 27/00		E-8226-5K	
H 04 B 1/74		6745-5K	

Examination Request: Not Requested yet No. of inventions: 1 (4 pages altogether)

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(54) Name of Invention: Communication Method

(21) Patent Application No.: S[-howa] 61-288531
(22) Application [Date]: Dec. 3, 1986

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(74) Agent: Patent Agent Minoru Aoyagi

[Column 1]
Specification
1. Name of Invention

Communication System

2. Scope of Claims of Patent

In connection with a communication system in which circuits are formed between, and signals are transmitted and received mutually by, multiple stations (A, B, ...), when a circuit between certain two stations has deteriorated, a communication system that is characterized by adoption of a modulation method for communication between any and every combination of two such stations, such that there is some room to spare in the communication capacity, and by having a constant communication capacity on the said deteriorated circuit such that the communication on the said circuit is continued by reducing communication capacity of the deteriorated circuit and by reducing required C/N, and that the reduced portion is supplemented by rerouting [it] to another circuit.

3. Simple Explanation of the Invention

(Outline)

By changing a modulation system of radio equipment used in a line comprising a closed loop, communication capacity is changed, and at the same time, reduced communication capacity rerouted to another line.

[Column 2]

(Field of [its] Industrial Use)

The present invention relates to: in connection with a closed loop line network comprised by relay stations that are scattered, a communication system on a transmission line by which these [said] stations communicate with one another.

(Conventional Technology)

As shown in Figure 1, there is a system in which multiple node stations A, B, ..., comprise lines with one another, thus forming a network. Each station transmits signals to, and receives signals from, one another, or signals are gathered in one certain station, and only control signals are communicated to all the stations as loop signals.

In such a communication network, for example, if a line between A and B is cut off due to some trouble, ordinarily communication between A and B is secured by using a fiberoptic cable that is installed as annex or by using another line [such as] ACB or ADB.

Or if a frequency reserve system is adopted between A and B, by having one line ready with a reserve unit of equipment per "n" units of currently used equipment as shown in Figure 6, if some trouble arises with one unit of the currently used equipment, it will be switched to the reserve unit.

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[Column 3]
(Problem that the invention is intended to solve)

In accordance with the system in Figure 6, a reserve unit of equipment must be prepared, however, and if this is placed for each node station, many units of radio equipment will be additionally required for an overall system. A system in which a fiberoptic cable is installed as annex as shown in Figure 1 would also require additional installation. A system in which another line is used cannot be implemented unless there is always enough room to spare [in the capacity].

The present invention is intended to improve on such [a drawback] and to deal with any trouble with a line using a fewer number of units of radio equipment.

(Means to solve the problem)

In accordance with the present invention, if a certain circuit, for example, a line between A station and B station in Figure 1 deteriorates due to rainfall etc., a line is secured by changing the modulation method of radio equipment at B station and by reducing required C/N though transmission capacity goes down, and at the same time, the reduced transmission capacity is compensated, [i.e.] the circuit capacity is secured by rerouting.

In other words, in connection with a communication system in which lines are formed between, and signals are
[Column 4]
transmitted and received mutually by, multiple stations (A, B, ...), when a line between certain two stations has deteriorated, the present invention is characterized by adoption of a modulation method for communication between any and every combination of two such stations, such that there is some room to spare in the communication capacity and by having a constant communication capacity on the said deteriorated line such that the communication on the said line is continued by reducing communication capacity of the deteriorated line and by reducing required C/N, and that the reduced portion is supplemented by rerouting it to another line.

(Operation)

According to this system, without having a reserve unit of radio equipment provided, even if there should arise some trouble with a line, by using the said troubled line to the extent that is usable and by using another line for deficiency, communication in the troubled line is enabled without losing any transmission amount.

(Embodiments)

Modulation methods used in digital microwave radio lines include 64 QAM, 16 QAM, 4 PSK, and 2 PSK, and these modulation systems are modified as desired in comprising lines.

[Column 5]
As a specific example, if the radio transmission speed were 1 Mb/s at the maximum, then with 64 QAM, it would be approximately 1 Mb/s X 6 for input to the modulator; with 16 QAM, 1 Mb/s X 4; with 4 PSK, 1 Mb/s X 2; [and] with 2 PSK, 1 Mb/s. Also, theoretical values of C/N (Carrier/Noise) required to secure error rate of 1×10^{-4} are [respectively]: for 64 QAM, approximately 24.5 dB; for 16 QAM, approximately 18.5dB; for 4 PSK, 11.4 dB; and for 2 PSK, approximately 8.4 dB.

Thus, since there is a difference of 6 dB at the incoming level (C/N), for example, between 64 QAM and 16 QAM, if a transmission line deteriorates and the required error rate (1×10^{-4}) could not be secured with 64 QAM any more, then the modulation method is to be changed to 16 QAM. In this manner, so long as the deterioration of the transmission route is 6 dB or less, the required error rate can be secured. By the change from 64 QAM to 16 QAM, however, the transmission amount is reduced to 2/3. So, the reduced portion (1 Mb/s X 2) is to be transmitted by way of other lines, for example, if the above changes were made due to the line trouble between A and B, then by using lines between AC and CB, or AD and DB.

[Column 6]
The transmission amount between A and B can be secured by this. Since transmission amount of the above-mentioned other lines will increase, however, they are to be operated under ordinary circumstances with some room to spare so that they can absorb the amount that is rerouted. Or in the alternative, if a modulation of 256 QAM is possible at the maximum, ordinarily operation is performed with 64 QAM modulation method, and if there arises a need to absorb a portion for rerouting, then change is made from 64 QAM to 256 QAM to create some room.

Figure 2 indicates a format of transmitted signals. One frame (F) is comprised of synchronous signals, a SV bit (for monitoring and controlling) and data. As for a change to a transmission path [is done as follows]: A condition of deterioration of a transmission path is determined by a radio line, and after a signal by an SV bit is transmitted to an opposite station, and a standard station, for example, "A" station, verifies the condition of this unit of radio equipment at the same time, signals to be inputted into the radio equipment are converted and then inputted into another unit of radio equipment. Incidentally, a station outside the loop that has a circuit control mechanism, as opposed to a standard station ("A" station) within the loop, may do the monitoring on deterioration conditions.

Figure 3 shows a structure of radio equipment to be placed in each station. This is comprised of logic 12, radio equipment unit 14, antenna 16, and control 18.

[Column 7]
A radio equipment unit having the same structure (shown as 20) is provided in each line (In Figure 1, each station has three lines, so each station has three such units.). These [radio equipment units] are connected to packet switching equipment 10 (If a line dies, this automatically allocates signals to normal lines that have spare capacities). Major parts of one unit of transmission equipment are shown in Figure 4. After detection of a radio line condition of its own station, an input signal string change is transmitted to a standard station via the above-mentioned SV signal. After that, if there is a signal string that can be ignored, amplitude levels of data that go into a four-phase modulator are controlled, control is exerted from 64 QAM to 2 PSK (other modulation methods such as 16 PSK and 8 PSK are also possible.). A receiver side is not shown in a figure, but it learns of a change to the modulation method by a signal dropping off.

Figure 5 shows signal strings of I and Q, and if vectors of 1 and 3 are used on each, then 16 values (16QAM) can be obtained. If only 3 of I and Q (ignoring 1) is used for synthesis, then 4 values (4 PSK) can be obtained. This switch from 16 values → 4 values is performed by Logic 12. S_1 is a reception state signal that forms a basis which causes this switch. Similarly, it can be applied to modulation methods of 64 QAM and 256 QAM.

[Column 8]
If 16 QAM is made the standard transmission capacity of each line, and then if 64 QAM is used when a circuit is in a good condition, and if 4 PSK or 2 PSK is used when the circuit deteriorates, in the above-mentioned embodiment, each circuit has 1 Mb/s X 2 to spare at all times, and this can be used as capacity for the deteriorated circuit.

(Effect of the invention)
As described above, in accordance with the present invention, without having a reserve radio equipment unit provided, even if some trouble arises with a line, by using the said troubled circuit to the extent it is usable and by using [an]other circuit[s] for deficiency, communication is enabled without reducing a transmission amount of the troubled circuit. Even without using space diversity, if channel capacity is reduced, with 64 QAM → 2 PSK, an improvement of approximately 16 dB at C/N is obtained, and a certain extent [of improvement] can be secured on the troubled circuit by this method. It is also effective as countermeasure for a drop of transmission performance due to such things as weather conditions and some obstacles appearing.

[Column 9]
1
4. Simple explanation of figures
Figure 1 is a figure that describes a circuit network to which the present invention is applied.
Figure 2 is a figure that describes a format of transmitted signals.
Figure 3 is a block diagram that shows a structure of each node station.
Figure 4 is a block diagram that shows a structure of transmission equipment for one circuit.
Figure 5 is a figure that explains 16 QAM.
Figure 6 is a figure that explains one example of a conventional system.

In Figure 1: A, B, ..., are node stations; [and] l_1, l_2, ..., are circuits.
In Figure 3: 10 is a switch; [and] 16 is an antenna.

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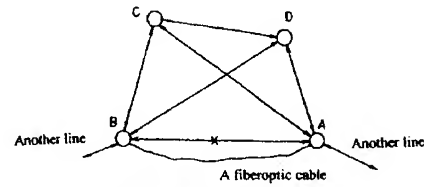


Figure that depicts a line network to which present invention is applied
Figure 1

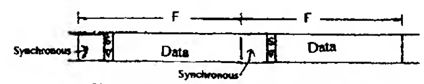
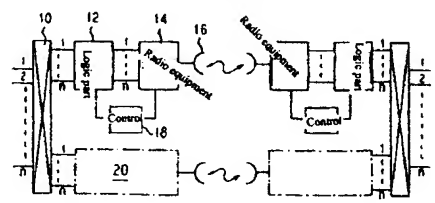
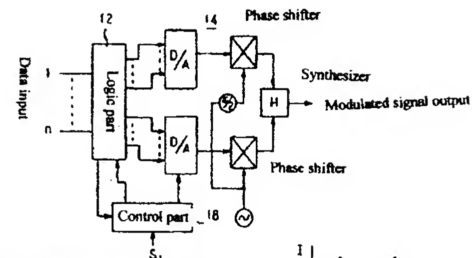


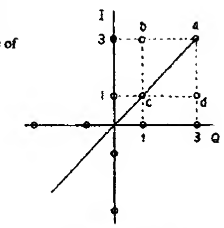
Figure that depicts a format of transmission signals
Figure 2



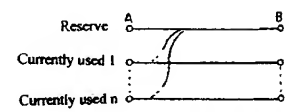
A block diagram indicating structure of each node station
Figure 3



A block diagram indicating structure of transmission equipment
Figure 4



A figure depicting 16 QAM
Figure 5



A figure depicting a conventional system
Figure 6

467QB00851546

⑲日本国特許庁（JP）　⑪特許出願公開

⑫公開特許公報（A）　昭63－141432

⑤1Int.Cl.⁴	識別記号	庁内整理番号	⑬公開　昭和63年(1988)6月13日
H 04 L 27/00		E－8226－5K	
H 04 B 1/74		6745－5K	

審査請求　未請求　発明の数 1　（全4頁）

⑤4発明の名称　通信方式

⑳特　願　昭61－288531

㉒出　願　昭61(1986)12月3日

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明　細　書

1.発明の名称

通信方式

2.特許請求の範囲

複数局（A，B，……）の相互間に回線を構成して互いに信号を送受する通信方式において、

全ての2局間の通信に、通信容量に余裕を持つ変調方式を採用し、

ある2局間の回線が劣化したとき、変調方式を変更して、劣化した回線の通信容量を下げ、所要C／Nを下げて該回線の通信を続行すると共に、減少した分を他の回線を迂回させることで補足して、該劣化回線の通信容量を不変にすることを特徴とする通信方式。

3.発明の詳細な説明

〔概　要〕

閉ループを構成している回線に用いる無線機の変調方式を変更して、通信容量を変更すると共に、減少した通信容量を他の回線に迂回させる。

〔産業上の利用分野〕

本発明は、散在する中継局が閉ループ回線網を構成し、これらの局が互いに通信を行なっている伝送路の通信方式に関する。

〔従来の技術〕

第1図に示すように複数のノード局A，B，……が相互に回線を引き、網を形成しているシステムがある。各局は互いに信号を送受信し、又はある特定局に信号に集結させ、制御信号のみループ信号として全局に通信させる。

このような通信網では、例えばA，B間で障害のため回線が切れたとき、併設してある光ケーブルを使用して又は他のルートACB、ADBを使用して、AB間の通信を確保するのが通常である。

またA，B間で周波数予備方式を採用している場合、第6図に示すように現用機n台に1台の予備機による回線を用意しておき、現用機1台が障害を起したとき予備機に切換える方式を採用している。

1　2

〔発明が解決しようとする問題点〕

しかしながら第6図の方式では予備機を用意せねばならず、各ノード局にこれを置くと全体では多数の無線機が余分に必要になる。また第1図のように光ケーブルなどを併設する方式もやはり余分の設備が必要になり、他のルートを経由する方式も常時余裕を持たせておくのでなければ実施できない。

本発明はかゝる点を改善し、少ない無線機で回線障害に対処しようとするものである。

〔問題点を解決するための手段〕

本発明では、ある回線例えば第1図のA局、B局間の回線が降雨などによって劣化するとき、A，B局の無線機の変調方式を変更し、伝送容量は下るが所要C／Nを下げて回線を確保すると共に、減少した伝送容量は他回線を迂回させて回線容量を確保する。

即ち本発明は、複数局（A，B，……）の相互

間に回線を構成して互いに信号を送受する通信方式において、全ての2局間の通信に、通信容量に余裕を持つ変調方式を採用し、ある2局間の回線が劣化したとき、変調方式を変更して、劣化した回線の通信容量を下げ、所要C／Nを下げて該回線の通信を続行すると共に、減少した分を他の回線を迂回させることで補足して、該劣化回線の通信容量を不変にすることを特徴とするものである。

〔作用〕

この方式によれば、予備無線機などを設けずに、回線障害が生じても当該障害回線を使用可能な範囲で使用し、不足分は他回線を利用することで、障害回線の伝送量を落とすことなく通信が可能になる。

〔実施例〕

デジタルマイクロ波無線回線で用いている変調方式としては64QAM、16QAM、4PSK、2PSK等があり、これらの変調方式を任意に変

更して回線を構成する。具体例として無線伝送速度を最大1Mb／sとすると、64QAMでは、変調器入力では約1Mb／s×6本、16QAM、4PSK、2PSKでは1Mb／s×4、1Mb／s×2、1Mb／sとなる。また誤り率1×10^{-4}を確保するための所要C／N（Carrier／Noise）の理論値は64QAM、16QAM、4PSK、2PSKでは各々約24.5dB、18.5dB、11.4dB、8.4dBとなる。

このように例えば64QAMと16QAMでは着信レベル（C／N）で6dBの差があるので、伝送路が劣化して64QAMでは所要の誤り率（1×10^{-4}）を確保することができなくなれば変調方式を16QAMに変える。このようにすれば伝送路劣化が6dB以内なら所要の誤り率を確保することができる。しかし、64QAMから16QAMへの変更により伝送容量は2／3に減少する。そこで減少分（1Mb／s×2本）を他回線、例えばAB間が回線障害で上記のようにしたのであればAC，CB又はAD，DB間回線を利用し

て伝送する。これによりAB間の伝送容量を確保できる。但し上記他回線の伝送容量は上るので、常時は余裕を持って運用し、迂回分を吸収できるようにしておく。或いは最大256QAMの変調方式が可能であるとして常時は64QAM変調方式で運用し、迂回分を吸収する必要が生じたら64QAM→256QAMの変更を行ない、余裕を作る。

第2図は伝送信号のフォーマットを示し、1フレーム（F）は同期信号、SV（監視、制御用）ビット、データからなる。伝送路の変更は、無線回線で伝送路の劣化状況を判断し、対向局にSVビットで信号を送受すると共に、基準局例えばA局中でこの通信網の状況を確認後、無線機に入力される信号を変換させ、他の無線機に入力する。なお劣化状況の監視はループ中の基準局（A局）でなく、ループ外の回線統制機構を持った局で行なってもよい。

第3図は各局に設けられる無線機の構成を示し、これは論理部12、無線機14、アンテナ16、

制御部１８からなる。同様構成の無線装置（２０で示す）が各回線に設けられ（第１図では各局は３回線を持っているので各局３組）、これらはパケット交換機（これは回線が死ぬと信号を正常な余っている回線へ自動的に振り分ける）１０に接続される。この１組分の送信側要部を第４図に示す。自局無線回線状態を検出後、前記ＳＶ信号を通して基準局に入力信号列変更を送出する。その後、無視できる信号列があれば４相変調器に入るデータの振幅レベルを制御し、６４ＱＡＭから２ＰＳＫまで制御する（他の変調方式１６ＰＳＫ，８ＰＳＫなども可能）。受信側は図示しないが、信号欠落により変調方式の変更を知る。

第５図はＩ，Ｑの信号列を示し、各々１，３のベクトルを用いれば１６値（１６ＱＡＭ）が得られ、Ｉ，Ｑの３のみ（１は無視して）で合成すれば４値（４ＰＳＫ）となる。この１６値→４値の変換は論理部１２で行なう。Ｓｉはこの切換えを行なわせる元になる受信状態信号である。同様に６４ＱＡＭ，２５６ＱＡＭの変調方式の適用も可能である。

各回線の１６ＱＡＭを標準の伝送容量とし、回線の状態がよい時は６４ＱＡＭを使用し、回線が劣化したとき４ＰＳＫまたは２ＰＳＫを用いれば、各回線で上記の例は１Ｍｂ／ｓ×２本が常時余裕であり、この回線を劣化した回線の容量とすることもできる。

〔発明の効果〕

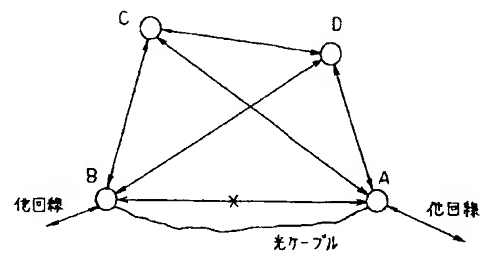
以上説明したように本発明によれば、予備無線機などを設けずに、回線障害が生じても当該障害回線を使用可能な範囲で使用し、不足分は他回線を利用することで、障害回線の伝送量を落とすことなく通信が可能になる。スペースダイバーシチを用いなくても、チャンネル容量を減少させれば６４ＱＡＭ→２ＰＳＫで、Ｃ／Ｎで約１６ｄＢ程度の改善が得られ、障害回線もこの方式である程度確保することが可能であり、気象条件、障害物発生などによる伝送能力の低下に対する対策として有効である。

4.図面の簡単な説明

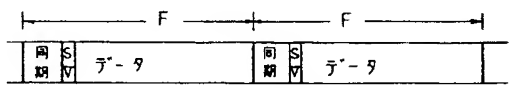
第１図は本発明を適用する回線網の説明図、
第２図は伝送信号のフォーマットの説明図、
第３図は各ノード局の構成を示すブロック図、
第４図は１回線分の送信装置の構成を示すブロック図、
第５図は１６ＱＡＭの説明図、
第６図は従来方式の一例の説明図である。

第１図でＡ，Ｂ，……はノード局、ℓ_1，ℓ_2，……は回線、第３図で１０は交換機、１６はアンテナである。

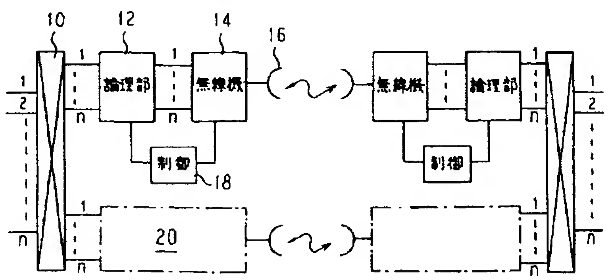
出願人　富士通株式会社
代理人弁理士　青柳稔



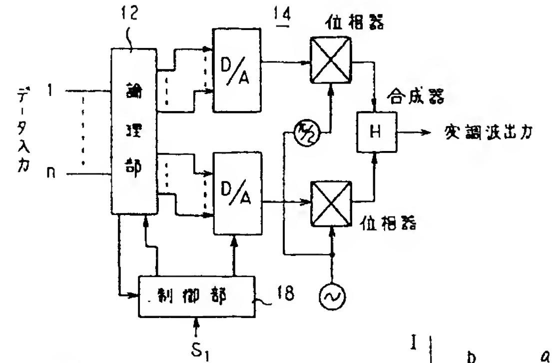
本発明を適用する回線網の説明図
第1図



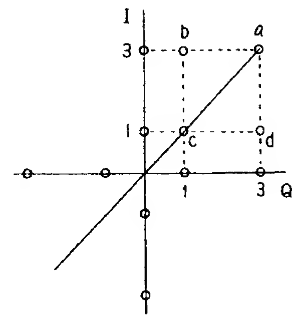
伝送信号のフォーマットの説明図
第2図



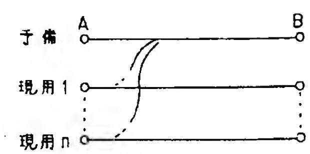
各ノード局の構成を示すブロック図
第3図



送信装置の構成を示すブロック図
第4図



16QAMの説明図
第5図



従来方式の説明図
第6図